

NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

Mobile River Basin

MAJOR WATER-QUALITY ISSUES IN THE MOBILE RIVER BASIN

Assessing water quality in the Mobile River Basin is important for the protection and efficient use of water and other aquatic resources. The Mobile River Basin NAWQA study is intended to increase the scientific understanding of surface- and ground-water quality within the basin and the factors that influence water quality.



The blue shiner is listed as a threatened species in Alabama. (Photograph courtesy of Malcolm Pierson)

This NAWQA study also provides information needed by water-resource managers to implement effective water-quality management actions and evaluate long-term changes in water quality. During the planning process, the following water-quality issues that currently face water-resource managers in the Mobile River Basin were prioritized:

- **Nutrient enrichment** of ground and surface waters from human and animal wastes and runoff from urban and agricultural areas.
- **Sedimentation** and increased concentrations of sediment in streams and reservoirs from erosion related

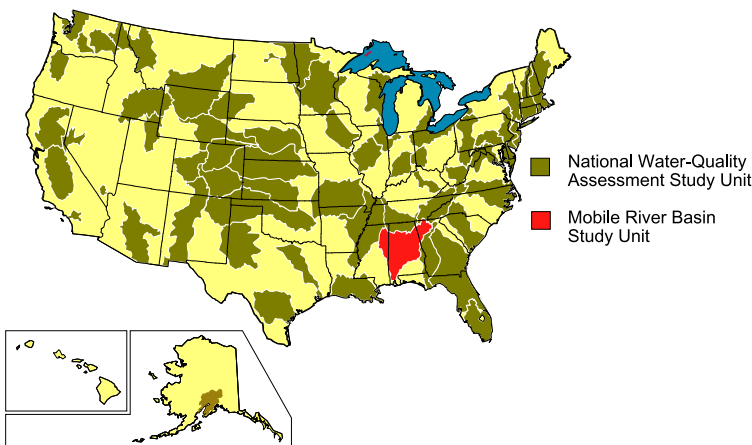
to urbanization, agriculture, and silviculture.

- **Pesticides and toxics** compounds in surface and ground water from agricultural, industrial, and urban activities.
- **Degradation of instream and riparian habitats** and the subsequent impacts upon native species and water quality.

- Effects of **acid-mine drainage** on surface-water quality.
- **Bacterial contamination** of surface and ground waters.
- The quality of surface- and ground-water discharges to Mobile Bay and how they relate to the **health of the estuarine environment and its fisheries**.

WHAT IS THE NATIONAL WATER-QUALITY ASSESSMENT PROGRAM?

During the past 25 years, industry and government made large financial investments intended to improve water quality across the Nation; however, many water-quality issues remain. To address the need for consistent and scientifically sound information for managing the Nation's water resources, the U.S. Geological Survey began a full-scale National Water-Quality Assessment (NAWQA) Program in 1991. This program is unique compared to other national water-quality assessment studies in that it integrates the monitoring of the quality of surface and ground waters with the study of aquatic ecosystems. The goals of the NAWQA Program are to (1) describe current water-quality conditions for a large part of the Nation's freshwater streams and aquifers (water-bearing sediments and rocks), (2) describe how water quality is changing over time, and (3) improve our understanding of the primary natural and human factors affecting water quality.



Assessing the quality of water in every location in the Nation would not be practical; therefore, NAWQA Program studies are conducted within a set of areas called study units. These study units are composed of 59 important river and aquifer systems that represent the diverse geography, water resources, and land and water uses of the Nation. The Mobile River Basin is one such study unit, designed to address issues relevant to the Mobile River Basin while supplementing water-quality information collected in other study units across the Nation. The U.S. Geological Survey began the Mobile River Basin NAWQA study in 1997.

STUDY UNIT DESCRIPTION

The Mobile River Basin encompasses 44,000 square miles (mi²) in Georgia, Tennessee, Alabama, and Mississippi and comprises the Alabama and Tombigbee Rivers that meet to form the Mobile River. The Mobile River flows south into Mobile Bay, which discharges into the Gulf of Mexico. Approximately 71 percent of the study unit lies within Alabama, 14 percent in Mississippi, 13 percent in Georgia, and 2 percent in Tennessee. An estimated 4.9 million people lived in the study unit in 1990. The largest population centers in the study unit (populations greater than 100,000) include Birmingham, Mobile, Montgomery, and Tuscaloosa.

The major land use in the Mobile River Basin is forested land, which covers approximately 69 percent of the study unit. The remaining land uses include agricultural land (18 percent), urban (2 percent), and other uses such as wetlands, streams, lakes, and reservoirs (11 percent). Agricultural activities include row crops such as cotton, corn, hay, and soybeans, as well as aquaculture, and poultry and cattle production. Major industries include silviculture, chemical, pulp and paper, iron and steel, coal, textile manufacturing, and hydroelectric power.



U.S. Geological Survey photo

Silviculture is the largest industry in Alabama.

The Mobile River basin is the sixth largest basin in the Nation and the fourth largest in terms of streamflow. The mean annual streamflow of the Mobile River is about 64,000 cubic feet per second (ft³/s). The Alabama River Basin, which drains 22,800 mi², annually contributes 33,600 ft³/s of streamflow to the Mobile River, whereas the Tombigbee River Basin (20,200 mi²) annually contributes 30,200 ft³/s. Major tributaries to the Alabama River are the Coosa (10,161 mi²), Tallapoosa (4,675 mi²), and Cahaba (1,825 mi²) River Basins, which have a combined mean annual streamflow of 24,000 ft³/s, or 71 percent of the mean annual streamflow from the Alabama River Basin. The principal tributary to the Tombigbee River is the Black Warrior River Basin (6,276 mi²), which has a mean annual streamflow of 9,800 ft³/s and is about 32 percent of the mean annual streamflow from the Tombigbee River Basin. Flow in the Alabama

and Tombigbee Rivers is generally regulated by upstream reservoirs, flood-control and navigational locks and dams, and hydroelectric plants. In 1985, the Tennessee-Tombigbee Waterway was opened. It joined the Tennessee and Tombigbee Rivers to provide a new trade route connecting Mobile and the Gulf Coast with the mid-section of the Nation. Reservoirs on the Alabama and Tombigbee Rivers and their tributaries are also used for drinking water and recreational activities such as fishing, swimming, and boating.

Landforms in the Mobile River Basin study unit range from rugged mountains to coastal lowlands and are included in five physiographic provinces. The Blue Ridge and Piedmont, located in the northeast corner of the study unit, are characterized by igneous and metamorphic rocks and encompass 16 percent of the basin. To the east, the Valley and Ridge consists of a series of parallel ridges and valleys, all having a northeast trend. It is underlain by sandstone, shale, limestone, and dolomite rocks. The Valley and Ridge includes 16 percent of the basin. The Appalachian Plateaus, which encompasses 12 percent of the basin, is dominated by relatively flat plateaus and is underlain largely by nearly flat-lying sandstones, limestones, and shales. The remaining 56 percent of the study unit is included in the Coastal Plain, which is primarily underlain by unconsolidated or poorly consolidated sands, gravels, clays, and limestones. Elevations in the study unit range from near sea level along the Mobile River in the Coastal Plain to greater than 3,000 feet above sea level in the Blue Ridge Mountains of Georgia. Average annual precipitation ranges from 50 to greater than 60 inches, with higher amounts in the mountainous regions; average annual runoff ranges from 18 to 30 inches. Average annual air temperatures vary from about 60 degrees Fahrenheit (°F) in the north to about 70° F in the south.

The Blue Ridge and Piedmont are underlain by a fractured, crystalline-rock aquifer characterized by little or no pore spaces and openings and the overlying unconsolidated, weathered rock remnants and soil. The Valley and Ridge and Appalachian Plateaus are underlain by fractured-rock systems in the well-consolidated sandstones and interconnected fractured rock systems in the cavernous limestone and dolomite rocks which become enlarged as water flows through them. Caves and sinkholes in the limestone rocks increase the susceptibility of ground water to contamination from surface water. The Coastal Plain is



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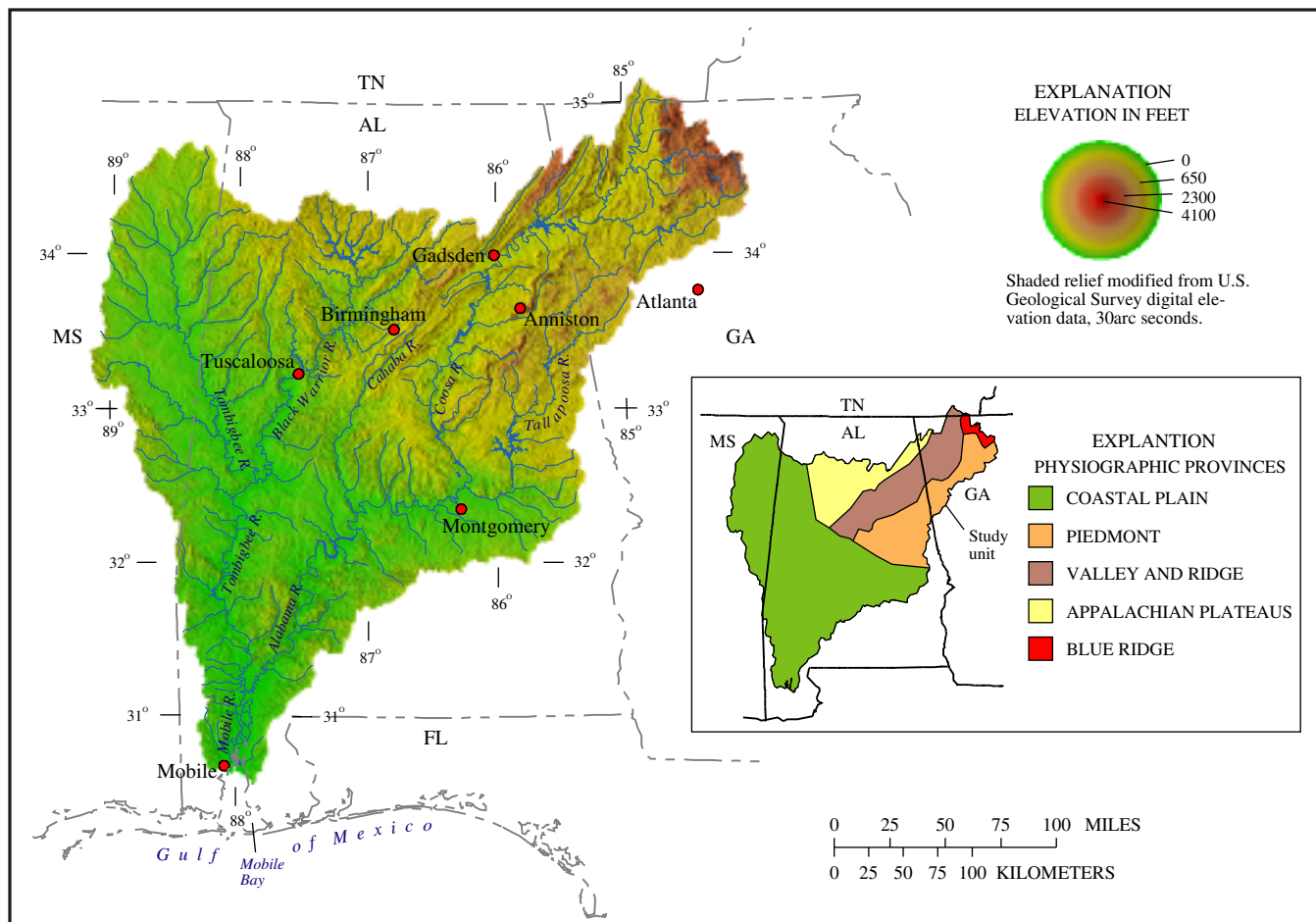
Birmingham is the largest city in the study unit. Continued residential development may stress the aquatic habitats of suburban streams.

primarily underlain by sand and gravel aquifer systems which are important sources for drinking water. Water in the Coastal Plain is produced from shallow ground water and from deep ground water which is confined by impermeable layers of chalk and clay deposits.

Based on 1995 water-use data, approximately 1,340 million gallons per day (Mgal/d) were withdrawn from surface- and ground-water sources for public, commercial, and domestic supplies and for industrial and agricultural uses in the Mobile River Basin. Surface water is the principal source, accounting for about 76 percent of the water withdrawn (1,020 Mgal/d); about 42 percent is used for public-water supplies (430 Mgal/d) and 44 percent is used for industrial purposes (453 Mgal/d). Approximately 76 percent of the ground-water withdrawals were used for public and domestic drinking-water supplies (198 and 49 Mgal/d, respectively). More than 80 percent of the public-water supplies were from surface-water sources in the non-Coastal Plain Provinces, whereas nearly 60 percent of the public-water supplies were from ground-water sources in the Coastal Plain.



Fishing is one of the recreational uses of reservoirs in the Mobile River Basin. (Photo courtesy of the Alabama Bureau of Tourism and Travel)



SCHEDULE OF STUDY ACTIVITIES

Activity	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Plan and review														
Intensive data collection														
Reports														
Low-intensity monitoring														

The Mobile River Basin study is one of several NAWQA studies that began in Federal fiscal year 1997 (October 1996). Study planning and design, and analysis of existing data will be done during the first 2 years, which is consistent with all NAWQA studies. After the 2-year planning period, surface- and ground-water and biological data will be collected intensively for 3 years during a high-intensity phase. A low-intensity phase follows for 6 years, during which water quality will be monitored at a selected number of sites and areas assessed during the high-intensity phase. This combination of high- and low-intensity-monitoring phases allows the NAWQA Program to examine trends in water quality over time.

During the planning period, existing data and results from previous studies will be reviewed to understand the primary physical, chemical, and biological factors that affect water quality in the study unit and to identify gaps in the current data. Information obtained from reviews of previous studies, along with field checks of existing monitoring stations and candidate sampling sites and field reconnaissance data, will be used to design a sampling program for the study unit.

During the high-intensity phase, new chemical, physical, and biological data will be collected from selected areas on local and regional scales to describe the quality of water throughout

the study unit. Measurements will be made to determine water chemistry in streams and aquifers; the quantity of suspended sediment and the quality of bottom sediments in streams; the variety and number of fish, benthic invertebrates, and algae in streams; and the presence of contaminants in fish tissues. Individual streams and aquifers, chemical constituents, and biological species will be selected for sampling to represent the important water resources and water-quality concerns in the study unit and the Nation. A series of technical and nontechnical reports describing results of high- and low-intensity-phase data collection and analysis are planned.

ASSESSING WATER QUALITY IN THE MOBILE RIVER BASIN STUDY UNIT

The NAWQA Program is designed to assess the status of and trends in the quality of the Nation's ground- and surface-water resources and to link the status and trends with an understanding of the natural and human factors that affect the quality of water. Consistent data-collection and assessment methods in all NAWQA studies make this possible and are critical for providing uniform and comparable information on water quality for the nation. Surface-water, ecological, and ground-water studies are done on local (a few square miles to hundreds of square miles) and regional (thousands of square miles) scales to understand the water-quality conditions and issues within a study unit. NAWQA study-unit data collected using this multiscale, interdisciplinary approach will be aggregated to provide national-scale water-quality assessments. Partnerships and cooperative studies between local, State, and Federal agencies can be developed to help meet specific needs. The basic design for the Mobile River Basin study unit described in the following sections is similar among NAWQA study units nationwide.

Surface Water

Surface-water quality is monitored at two types of sites, basic-fixed sites and intensive-fixed sites, which are determined by the frequency of the sampling. Most NAWQA study units have about eight basic-fixed and four intensive-fixed sites. Basic-fixed sites are sampled on a regular basis, usually monthly, for 2 years during the 3-year high-intensity phase. Intensive-fixed sites are monitored more frequently for at least 1 year to characterize short-term variations of water quality. Both types of sites are used to monitor water-quality constituents, such as basic field properties, major ions, nutrients, and pesticides. Volatile organic compounds (VOC's) and trace elements also may be monitored at selected sites. Monitoring sites are selected to determine representative water-quality conditions in relation to important environmental settings in the study unit.

Basic-fixed or intensive-fixed sites are further classified as either indicator or integrator sites. Indicator sites represent relatively homogeneous and usually small basins associated with environmental settings, such as a specific land use that is considered to be important for understanding water-quality in the study unit. Integrator sites are established at downstream points in large drainage basins that incorporate complex combinations of land-use settings. Water quality at integrator sites reflects the effects of multiple land uses and transport in the basin.

Synoptic surface-water sampling can be used to address a selected issue in one

river basin or to provide greater spatial coverage and allow investigators to assess relations of fixed sites to streams throughout the study unit. Synoptic surface-water sampling involves short-term investigations of specific water-quality conditions at numerous sites during selected hydrologic periods, such as periods of low streamflow.

Ecology

Ecological studies in conjunction with surface-water sampling activities are conducted to provide insight into ecological variability over time, relations between water quality and community structure and stability, and ecological differences with respect to various environmental settings. Aquatic biological communities are surveyed at basic- and intensive-fixed sites during the 3-year high-intensity phase. These investigations are conducted along delineated stream reaches and include aquatic and riparian habitat assessments and annual surveys of fish, algal, and benthic invertebrate communities. Trace elements and synthetic organic compounds are analyzed in bed sediment and fish tissue at selected sites to determine their occurrence and distribution and relation to land use and environmental setting. Ecological synoptic studies are conducted to evaluate spatial variability of biological communities or address issues of special concern within the study unit.

Ground Water

Ground-water studies in the NAWQA Program are typically composed of three components: (1) study-unit survey, (2) land-use studies, and (3) an optional flow-path study. The study-unit survey is intended to characterize water quality in the major aquifers of the study unit without targeting specific land uses. About 30 wells are randomly selected for sampling in each major aquifer subunit in the study unit. Ground-water samples are analyzed for major ions, nutrients, and pesticides. Trace elements and VOC's also may be monitored.

Land-use studies attempt to characterize the quality of shallow ground water associated with a particular land-use setting. Land-use studies emphasize recently recharge ground water so that the influences of land-use practices and environmental settings can be assessed. About 30 wells are randomly selected within a selected land-use setting for an aquifer. Results from land-use studies will be compared with results from study-unit surveys to determine the effect of land use on ground-water quality.

Flow-path studies are intended to help identify and quantify processes controlling shallow ground-water movement and quality. These studies, performed in selected study units, are designed to trace chemical changes that occur in water as it enters the ground-water flow system, travels along a flow path, and eventually discharges into surface waters.

COMMUNICATION AND COORDINATION

Communication and coordination between the U.S. Geological Survey and other scientific and land- and water-management organizations are critical components of the NAWQA Program. Each study unit maintains a liaison committee consisting of representatives from Federal, State, and local agencies, universities, the private sector, watershed organizations, and those who have water-resource responsibilities and interests. Committee activities include the exchange of information about regional and local water-quality issues, identification of sources of data and information, assistance in the design and scope of study products, and the review of study planning documents and reports. The liaison committee for the Mobile River Basin study met for the first time in October 1997.

The overall success of the Mobile River Basin NAWQA study will depend on the advice, cooperation, and information from many Federal, State, regional, and local agencies, and the public concerned about the basin's water resources. The assistance and suggestions of all are welcomed.

SUGGESTIONS FOR FURTHER READING

Gilliom, R.J., Alley, W.M., and Gurtz, M.E., 1995, Design of the National Water-Quality Assessment Program: Occurrence and distribution of water-quality conditions: U.S. Geological Survey Circular 1112, 33 p.

Leahy, P.P., Rosenshein, J.S., and Knopman, D.S., 1990, Implementation plan for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 90-174, 10 p.

FOR MORE INFORMATION

Information on technical reports and hydrologic data related to the NAWQA Program can be obtained from:

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Masthead photograph courtesy of the Alabama Bureau of Tourism and Travel